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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

December 18,2002

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: *Flexibility* ***for*** *Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band* – IB Docket No. 01-185

WRITTEN EX PARTE PRESENTATION

Dear Ms. Dortch:

The Wireless Communications Association International, Inc. is submitting this written **ex** *parte* presentation in response to the December 3, 2002 submission by Iridium Satellite LLC ("Iridium") proposing that the Commission defer deciding whether to allow mobile satellite service ("MSS") licensees to provide ancillary terrestrial services ("ATC") in the 1610-1626.5/2483-2500 MHz band (the "Big LEO" bands) until the Commission adjusts the Big LEO bandplan in a manner that "rectifies the spectrum inequity between Big LEO operators that has arisen due to the failure of several of the original licensees."[1] WCA is making this filing to re-emphasize that if the Commission does permit ATC in the Big LEO band, it must assure that ATC does not cause adjacent channel interference to terrestrial Multipoint Distribution Service ("MDS") and Instructional Television Fixed Service ("ITFS) operations in the immediately-adjacent 2500-2690 MHz ("2.5 GHz") band.

Although not addressed by Iridium's recent filing, this is hardly a new issue. Indeed, in the *Notice of Proposed Rulemaking ("NPRM")* that commenced IB Docket 01-185, the Commission clearly acknowledges that "[p]ermitting reuse of MSS spectrum for terrestrial

[1] Letter from Richard E. Wiley, counsel *to* **Iridium,** to Marlene H. Dortch, FCC Secretary, IB Docket NO. 185, at 1 (filed Dec. 3, 2002)["Iridium Request"].

services will require protection of adjacent channel and intraband operations . . . ."[2] The *NPRM* advises that "[i]f we adopt the flexible use proposed for MSS spectrum, we propose modeling technical rules on the rules currently in place for broadband PCS."[3] However, WCA's comments in response to the *NPRM* establish that while the broadband PCS technical rules provide a useful starting point for limiting interference from terrestrial use of MSS spectrum, they are not a complete solution absent the establishment of appropriate guardbands to protect MDS and ITFS usage from interference.[4] WCA's position should come as no surprise to the Commission, as it is fully consistent with positions taken by the United States Government before Working Party 8F of International Telecommunication Union ("ITU") Study Group 8 and by Working Party 8F itself.

Analyzing the potential for interference from ATC has been complicated by the unwillingness of the proponents of ATC to provide sufficient technical information regarding their proposed terrestrial systems for detailed studies to be performed. Unfortunately, despite WCA's long-standing request that MSS licensees submit substantially more technical information regarding **ATC,** Iridium's latest filing provides no details whatsoever as to how Iridium proposes to deploy ATC operations in the 2495-2500 MHz band.[5] However, from earlier submissions by MSS Licensees, it appears that at least some MSS licensees contemplate ATC operations that will essentially conform to the technical characteristics of Frequency Division Duplex ("FDD") IMT-2000 systems.[6] And, since the Commission's 1998 decision allowing MDS and ITFS licensees to routinely provide two-way broadband services,' many MDSIITFS licensees have deployed, or have developed plans to deploy, facilities in the 2500-2690 MHz band that comport with the IMT-2000 FDD and Time Division Duplex ("TDD") standards.[8]

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[2] *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Bund, the L-Bund. and the 1.6/2.4 GHz Band,* FCC 01-225, IB Docket No. 01-185, at ¶ 34 (rel. Aug. 17, 2001)["*NPRM*"].

[3] *Id.*

[4] ***See*** Comments of Wireless Communications Ass'n Int'l, **IB** Docket No. 01-185, at 2-5 (filed Oct. 22, 2001)["WCA Comments"]. **A** copy of WCA's comments **is** annexed as Attachment **A.**

[5] *See* WCA Comments, at 4-5

[6] *See, e.g.* Letter from William Wallace, Counsel to Globalstar, to Marlene H. Dortch, IB Docket No. 01-185, Appendix at 2-3 (filed May 29, 2002)["Globalstar May 29, 2002 Letter"].

[7] *See Amendment of Purls 21 und 74 to Enable Multipoint Distribution Service And Instructional **Television** Fixed Service Licensees to Engage in Fixed Two-Way **Transmissions,*** 13 FCC Rcd 19112 (1998); ***on*** *recon.* 14 FCC Rcd 12764 (1999); *onfurtherrecon.* 15 FCC Rcd 14566 (2000).

[8] *See Amendment of Part 2 of the Commission's Rules* Io *ALlocate Speclrum **Below 3** GHz for Mobiel and Fixed Services to Support the Introduction of New Advanced Wireless Services. including Third Generation Wireless Services,* 16 FCC Rcd 17222, 17331 (2001)(dicussing IPWireless, Inc. IMT-2000-compliant MDS/ITFS TDD

There has already been substantial progress by Working Party 8F in determining the guardband requirements between adjacent TDD and FDD services. That work clearly establishes the substantial **risk** that ATC in the Big LEO band will cause harmful interference to MDS/ITFS operations in the 2.5 GHz band. For example, annexed as Attachment B is a submission made by the United States Government to Working Party 8F just fourteen months ago that concluded:

> The interference analysis presented in this paper shows that significant interference exists when TDD and FDD systems arc collocated. The noise floor of both systems is impacted considerably, thereby decreasing cell coverage and capacity. *Even a guardhand of **5** MHz and 10 MHz **will** noi eliminate the problem*, as shown in the analysis. Without sufficient guardbands, interference conditions will also cause receiver overdrive of both systems. Sufficient guardbands must therefore be provided between TDD and FDD allocations. Continued investigation is required to define an appropriate guardband **size** considering real world operation issues such as base station collocation.[9]

As a result of that and a variety of other submissions, Working Party 8F prepared a draft report entitled "Coexistence between IMT-2000 TDD and FDD radio interface technologies within the frequency range **2** 500-2 690 MHz operating in adjacent bands and in the same geographical area" for submission to ITU Radiocommunication Study Group 8.[10] A copy of that report is annexed as Attachment C. This report is squarely on point, as it specifically addresses the guardband requirements associated with the use of FDD and TDD technologies utilizing adjacent spectrum. Most significantly, this report concludes that even with a guardband of 10-15 MHz, substantial separation distances will be required to avoid interference between TDD and FDD systems. For example, Table 25 of the Working Party 8F report establishes that even with a carrier separation of 15 MHz, **a** 2.65 mile separation may be required between base stations where an FDD base station is located adjacent to a TDD base station. While WCA agrees with Working Party 8F that there may be mitigation techniques that could be utilized to reduce the required separation distance, the findings of Working Party 8F show beyond peradventure that a

system). In many cases, those implementation **of** those plans have been delayed **by** a variety of regulatory Impediments to the use of the 2.5 GHz band **for** two-way broadband services. Those impediments are described in detail in the white paper submitted recently by WCA, the National ITFS Association and the Catholic Television Network proposing a variety of changes to the MDS/ITFS regulatory regime designed to promote the deployment **of** the two-way systems envisioned by the Commission's 1998 action. **See** "A Proposal For Revising The MDS And ITFS Regulatory Regime," RM-10586, at 3-11.(filed Oct. 7, 2002).

[9] United States of America, "Interaction of TDD and FDD Systems: Interference Related to Cell Collocation of Adjacent-Band TDD and FDD Systems," Document 8F/4 IO-E, at **5** (Oct. 1, 2001)(emphasis added).

[10] Radiocommunication Study Group 8 is scheduled to consider Working Party 8F's draft report at its meeting February 4-5,2003 in Geneva. ***See*** ITU Radiocommunication Bureau Administrative Circular CACE/274, **at** Annex 1 (Nov. 8. 2002).

substantial guardband may be required in order to assure that any newly-authorized ATC service protects MDSIITFS."

Iridium's recent filing proposes two alternative reallocations of the Big LEO spectrum. Iridium's proposed new band plan **A** calls for the Commission (i) to reallocate the 2483.5-2488.5 MHz band for reauction, (ii) to restrict Globalstar to the 2488.5-2495 MHz band **for** downlink MSS and ATC, and (iii) to assign to Iridium the 2495-2500 MHz band for uplink and downlink MSS and for ATC. This proposed hand plan is unacceptable to the MDS/ITFS industry, as both Iridium and Globalstar would be permitted to engage in ATC operations so close to the 2.5 GHz band that interference to MDSIITFS operations is virtually assured. In contrast, adoption of Iridium's proposed new band plan B, which would limit ATC to the 2483.5-2490 MHz band, reduces the potential for interference from ATC to the 2.5 GHz band **if** the 2490-2500 MHz is designated as a guardband and used in a manner that protects MDS/ITFS and ATC from interference (perhaps for low-powered unlicensed applications).[12] While WCA cannot, at this juncture, state with certainty that a 10 MHz guardband between ATC and the 2.5 GHz band will be sufficient, Indium's proposal to limit ATC to the 2483.5-2490 MHz band certainly warrants further study.

In short, if the Commission is disposed towards authorizing ATC in the Big LEO bands, WCA urges the Commission to explore Iridium's band plan B, with the modification suggested above, as a possible approach to protecting MDSIITFS operations in the adjacent 2.5 GHz band.

Respectfully submitted,

Paul J. Sinderbrand

Attachments

cc: Bryan N. Tramont

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[11] This should come **as** no surprise to the MSS community. Indeed, Globalstar has previously conceded that in order to avoid interference to MDS/ITFS operations, "frequency and physical separation" will be required. Globalstar May 29, 2002 Letter, at 2. However, the cursory technical statement that accompanied Globalstar's filing was flawed by its assertion that adjacent channel interference from ATC into MDS/ITFS is attenuated by 40 dB **for** each one MHz **of** guardband. See ***id,*** Appendix, at 6. **As** is illustrated by Tables 10 through **14** of the **attached** Working Party 8F report. the rejection Characteristics are quite different than those assumed by Globalstar.

[12] Allowing the 2490-2500 MHz band to be used for terrestrial advanced wireless services **as** proposed by Iridium would pose the same threat to the 2.5 GHz band as allowing that band to be used for ATC. Ultimately, the problem is that advanced wireless terrestrial services, whether ATC or a stand-alone service offering, will have to be separated from the ***2.5*** GHz band to avoid interference.

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ATTACHMENT A

WCA COMMENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC **20554**

In the matter of	)	
	)	
Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, The L-Band, and the 1.6/2.4 GHz Band	))))	IB Docket No. 01-185
Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum at 2 GHz for Use by the Mobile Satellite Service	)))	ET Docket No. 95-18

COMMENTS OF
THE WIRELESS COMMUNICATIONS ASSOCIATION INTERNATIONAL, INC.

The Wireless Communications Association International, Inc. ("WCA") hereby submits its initial comments in response to the *Notice of Proposed* ***Rulemaking*** ("*NPRM*") in the above-referenced proceedings.[1]

With the *NPRM*, the Commission has solicited public comment on the possible terrestrial use of spectrum heretofore reserved for satellite transmissions by Mobile Satellite Service ("MSS") licensees. For the reasons set forth below, should the Commission permit the operation of terrestrial facilities in spectrum previously allocated solely for MSS satellite use, the Commission must condition such use on compliance with rules and policies designed io assure that terrestrial users of adjacent spectrum do not suffer harmful interference.

WCA is the trade association of the broadband wireless industry. **Its** members include, ***inter*** *alia*, licensees of the Multipoint Distribution Service ("MDS") and Instructional Television Fixed Service ("ITFS") spectrum at **21**50-2162 MHz **and** *2500-2690*

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[1] *Flexibility for* ***Delivery*** *of Communications by* ***Mobile*** *Satellite* ***Service Providers*** *in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Band*, FCC 01-225, IB **Docket** No. 01-185 (rel. **Aug.** ***17,*** 2001)[hereinafter cited **as** "*NPRM*"].

MHz. The MDS channels at 2150-2162 MHz are just 3 MHz from the MSS allocation at 2165-2200 MHz, and MDS/ITFS channel A1 is immediately adjacent to the MSS "Big LEO' allocation at 2483.5-2500 MHz. As such, WCA has a vital interest in assuring that any newly-authorized terrestrial operations in the MSS bands be regulated so as not to cause harmful interference to facilities in adjacent spectrum.

The Commission clearly shares WCA's concerns. The ***NPRM*** acknowledges that "[p]ermitting reuse of MSS spectrum for terrestrial services will require protection of adjacent channel and intraband operations, restrictions on tower heights and transmit power, and frequency stability."[2] Thus, the *NPRM* advises that "[i]f we adopt the flexible use proposed for MSS spectrum, we propose modeling technical rules on the rules currently in place for broadband PCS."' WCA's preliminary assessment is that the broadband PCS technical rules set forth in Sections 24.232 through 24.236 and 24.238 of the Commission's Rules provide a useful starting point for limiting interference from terrestrial use of MSS spectrum, but that appropriate guardbands will be required to protect MDS and **TIFS** usage from interference.[4]

The discussion in Paragraphs 54 through 66 of the *NPRM* illustrates that, at this time, there are **a** host of unanswered technical questions as to the how MSS spectrum would be utilized for the provision of terrestrial services.[5] Until the answers to those questions are

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' ***NPRM*, at ¶ 34.**

[3] *Id.*

[4] However, **as** noted *infra*, absent the imposition of guardbands between MSS terrestrial operations and MDS/ITFS spectrum the broadband PCS rules are not a complete solution.

[5] *NPRM.* ar ¶¶ 54-66. Moreover, it is worth noting that the Commission has not received any expression of interest by the Big LEO community to utilize **the** 2483.5-2500 MHz band for terrestrial services. ***See id.*** at ¶ 4. That is the band closest to any MDS or ITFS channels (being immediately adjacent to the 2500-2690 MHz band

provided by the proponents of terrestrial MSS operations, it is impossible for WCA to ascertain with any precision the sorts of technical restrictions on MSS terrestrial use that will be necessary to protect MDS and ITFS operations in neighboring bands.

However, even at this early stage it is clear that the *NPRM* is flawed by its failure to address the need for guardbands between MDS and ITFS (and possibly other services) and terrestrial MSS operations. Although the record in ET Docket No. 00-258[6], the *Advanced Wireless Services* proceeding, has **not** yet identified precisely the size of the guardbands required between MDS and ITFS operations and third-generation mobile wireless operations (which WCA assumes **will** be similar to terrestrial MSS services),[7] that record reflects a clear

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allocated for MDSIITFS operations) and thus the hand most vulnerable to interference from MSS terrestrial operations.

[6] *Amendment of Part 2 of the* ***Commission's Rules*** *to Allocate* ***Spectrum Below 3*** *GHz for* ***Mobile and Fixed*** *Services to* ***Support*** *the Introduction of* ***New Advanced Wireless Services. including Third Generation Wireless*** *Systems,* ET Docket 00-258, FCC 00-455 (rel. Jan. 5, 2001).

[7] The March 30, 2001 report by the Commission's staff **--** ***Final Report,*** "Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems" (the ***"Final Report")*** **–** concludes that to prevent interference between adjacent channel 3G systems and MDS/ITFS stations, guard bands of up to ***4*** MHz will be needed. ***Final Reporl,*** at 47-52. **In** response to the Commission's ***Public Notice*** soliciting comments from the public on the *Final Report*, "FCC Releases Staff Final Report "Spectrum Study of 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems", ***Public Notice***, **DA** 01-786 (rel. Mar. 30, 2001), WCA noted:

> **WCA** must take issue with the approach used in the ***Final Report*** for calculating the guardband necessary to protect MDS response station hubs (which are going to be the facilities most often requiring protection in the 2150-2162 MHz band). In essence, the *Final* ***Reporl*** concludes that a 4 MHz guardband is appropriate by making assumptions regarding the desired signal level for MDS/ITFS transmissions received at the MDS response station hub and then determining the size of the guardband necessary to yield a 0 dB desired-to-undesired signal level. While it is too early for WCA to determine whether the ***Final Report's*** conclusion – that a **4** MHz guardhand will protect MDS and 3G - is correct, WCA cannot agree with the use of a desired-to-undesired signal ratio to assure protection io the MDS response station hub. In its ***Reporl*** *and* ***Order*** in MM Docket No. 97-217, the Commission specifically rejected the use of desired-to-undesired signal ratios to protect response station hubs and instead adopted an approach whereby an adjacent channel newcomer is required to demonstrate that the proposed facility will not increase the noise floor at a reception antenna of the response station hub hy more than 45 dB. WCA submits that this approach provides a more realistic level of protection to MDS response station hubs and should he utilized in calculating the appropriate guardband between MDS at 2150-2162 **MHz** and any nearby 3G allocation.

consensus that there must be guardbands[8] and that the size of those guardbands is dependent upon whether the spectrum adjacent to MDS/ITFS is used for base-to-handset communications, or for handset-to-base communications.[9] The appropriate size for those guardbands will he dependent upon, among other things, the power levels and spectral masks required for MSS terrestrial operations (all other factors being equal, lower terrestrial MSS power levels and tighter terrestrial MSS masks translate into smaller guardbands). **WCA** intends to address the guardband issue in more depth if and when proponents of MSS terrestrial use provide sufficient information in response to the *NPRM* to allow a meaningful analysis.

In short, should the Commission permit terrestrial use of the MSS bands, the Commission will have lo use guardhands, power limits,[10] the spectral mask, and frequency stability requirements to craft an environment in which MDS and ITFS licensees will be free from interference caused by terrestrial operations on MSS spectrum. **WCA** looks forward to

Comments of WCA on FCC Final Report, ET Docket No. 00-258, at 4-5 (tiled April 16, 2001)(footnotes omitted)("WCA Supplemental Coniments"). ,**See** *also* Comments of **Sprint,** ET Docket No. 00-258, **at** 4-5 (filed April **16,** 2001).

[8] *See, e.g* WCA Supplemental Comments, at 4-5; Supplemental Comments of Verizon Wireless, ET Docket No. 00-258, at 7 (filed April 16, 2001); Letter from Steve Sharkey, Motorola, to Magalie Roman Salas, IB Docket No. 99-81(filed June 21, 2001)(proposing options for **2** GHz band plan that include guardbands between MDS and MSS/3G).

[9] *See Final Report,* at Appendix 5-2.

[10] The need for appropriate power limits to limit brute force overload interference has been highlighted by the year-long dispute in IB Docket No. 95-91 over the appropriate power levels for terrestrial repeaters operating in the Digital Audio Radio Service band. Although this is an issue of importance for **all** bands under consideration, it is of particular concern with respect to the proposal to permit terrestrial use of MSS spectrum that is adjacent to the MDS and ITFS bands. If permitted to operate **at** sufficiently high power levels, terrestrial MSS transmitters could cause substantial brute force overload interference to 2.5 GHz band usage that could not be filtered out given the practical limits of technology.

assisting the Commission in developing rules and policies that assure MDS and ITFS licensees arc protected against interference once proponents of terrestrial use of MSS spectrum provide further information regarding their plans.

Respectfully submitted,

THE WIRELESS COMMUNICATIONS
ASSOCIATION INTERNATIONAL, INC

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October 22, 2001

ATTACHMENT B

DOCUMENT 8F/410-E

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION
STUDY GROUPS

Delayed **Contribution**
Document 8F/410-E
1 October 2001
English only

United States of America

SPECTRUM

INTERACTION OF TDD AND FDD SYSTEMS: INTERFERENCE RELATED TO CELL COLLOCATION OF ADJACENT-BAND TDD AND FDD SYSTEMS

1 Description

This conhibution describes and quanti ties different sources of interference between adjacent-hand PDD and TDD systems when the two systems base stations are collocated. Specifically, this contribution accounts for interference into an PDD base station receiver from a collocated TDD base station transmitter, and interference into a TDD base station receiver from a collocated FDD base station transmitter. The analysis dcmonstratcs the existence of interference conditions, and is based on equipment performance assumptions taken from Document 8F/375, Attachment ***8.6*** and 3GPP specifications.

2 Introduction

Proponents of TDD technology have defined the benefits of TDD architecture to mobility systems in terms of increases in throughput, etc. The inclusion of TDD architecture would lead to discussion on the spectral allocation and placement of a TDD system in the presence of FDD systems. Deterministic calculations and Monte Carlo simulations presented within ITU-R Working **Party** 8F and documented in Document 8F/375, Attachment **8.6** show varied levels of interference between adjacent-band FDD and TDD systems. Various deployment scenarios **of** TDD and FDD, ranging from macro cell, micro cell, to pico cell combinations, have been studied. The results show a range of results, from significant interference in macro-to-macro cell combinations, to minimal interference in a pico-to-pico cell deployment. Document 8F/375, Attachment ***8.6*** defines a system as degraded when there is loss of cell capacity of 5% or more. The interference mechanisms reviewed in Document 8F/375, Attachment ***8.6*** are related to the increase in noise floor, which is only one of the factors that should be reviewed in a collocated site environment. To contribute to the understanding of the potential interference in a collocated TDD/FDD scenario, two kinds of degradations are considered in this paper:

a) receiver desensitization; and

b) receiver overload.

3 Interference mechanisms affecting collocated base stations

Collocation of multiple operators on the same tower or building is a common practice that will become more prevalent in future systems as the number of operators increases and more cell density is required for greater coverage and capacity. Because of deployment constraints, site acquisition difficulties, and other logistical and engineering issues, it is highly likely that WCDMA TDD and FDD sites would be co-sited (i.e. collocated). When collocated, mutual interference between the systems occurs and needs to be analysed. This mutual interference may present itself in several ways, such as receiver desensitization, overload, and/or inter modulation product interference, thereby degrading the performance of both systems. This paper presents a deterministic method to calculate the interference impact of collocated TDD and FDD systems for varying values of TDD/FDD channel separation.

A mobility environment contains several kinds of interference, some generated from within the system, and some generated by external systems occupying the adjacent frequency spectrum. The existence of this interference results in a decrease in system coverage and capacity caused by the raised noise floor of the base station receiver and the subsequent reduction in the receiver sensitivity.

Mathematical models for mutual interference evaluation

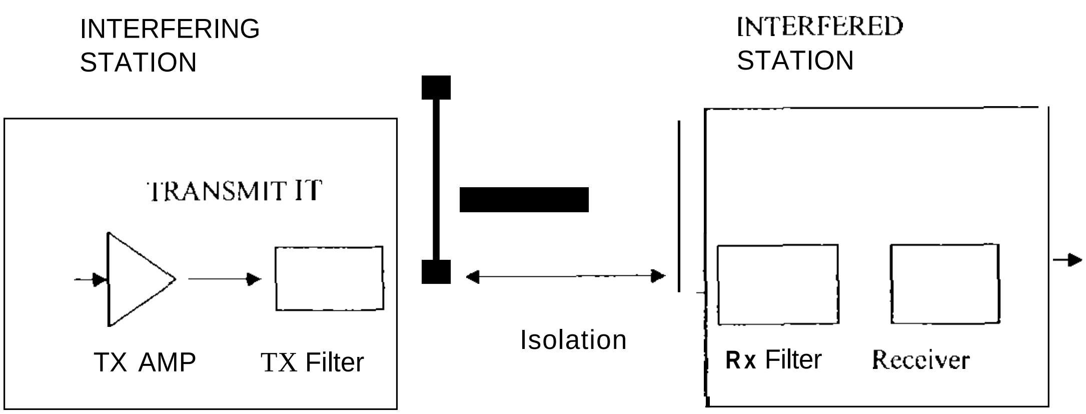

FIGURE 1

Schematic diagram showing mutual interference between two collocated RF systems

The RF components used in evaluating the mutual interference between two collocated base stations are a) The TX amplifier and TX filter of the interfering station; and b) RX filter and receiver (and a preamplifier) of the interfered station, as shown in Figure 1. The term "antenna isolation" refers to the total path loss between the antenna ports of the RX and TX units of the collocated base station, including the propagation loss and effective antenna gains of both stations For this analysis, "antenna isolation" is defined as the co-sited Minimum Coupling Loss (MCL) referenced in Document 8F/375, Attachment 8.6 as a value of 30 dB.

3.1 Receiver dcsensitization

Receiver desensitization is typically defined as the degradation in receiver sensitivity due to an increase in the receiver noise floor. It' the antenna isolation belween two collocated stations is not sufficient, and/or the interfering station's TX filter docs not provide enough out-of-band attenuation (rejection), the spurious emissions which fall into the RX band of the interfered station will result in an increase in the receiver's noise floor.

To avoid receiver desensitization, the noise floor of the receive band can be degraded by only a small amount. An acceptable degradation (increase) in noise floor has been defined in the United States in NSMA (National Spectrum Managers Association) Document WG 20.97.048;Revl.O titled "Inter-PCS-Co-block Coordination Procedure". It defines the degradation of approximately I dB as an acceptable limit between interfering digital systems. Mathematically, the 1 dB tolerance dictates that an interfering signal be at least 6 dB below the effective noise floor of the receiver. Therefore, the Maximum Allowable Interference (MAI) for receiver desensitization can be calculated as:

MAI_Desen (dBm) = Noise floor (dBm) + Receiver Noise Figure – 6 dB

Using the values defined in Document 8F/375, Attachment 8.6, the following results are calculated:

TABLE 1

Calculated thresholds for maximum allowable interference level for receiver desensitization

System	Noise floor	Rx noise figure	MAI (desen)
WCDMA TDD	–108 dBm	5 dB	–109 dBm
WCDMA FDD	–108 dBm	5 dB	–109 dBm

Spurious emissions are out-of-band harmonics and noise generated by power amplifier operation. It can be seen from Figure I that out-of-band interference power (such as spurious emissions) generated by the TX amplifier output of the interfering station is then partially attenuated by the TX filter. The interfering signal is then further attenuated by the antenna isolation between the two stations (co-sited MCL), and then received by the RX unit at the interfered base station. Once broadcast, the affected receiver system has no ability to filter these in-band emissions. Consequently, these signals appear as in-band receiver noise. The affected interference power received at the receiver-input port of the interfered station can be calculated from the following expression:

Int@_Rcvr = C_Tx_ – ACIR - **MCL**

where:

Int@_Rcvr = Affected Interference at the receiver input port of the interfered system (dBm)

C_TX_ = Nominal maximum carrier power level at the TX amplifier output (dBm)

ACIR = 1/(1/ACS+1/ACLR)

MCL = Minimum coupling loss (dBm) = 30 dB

The signal strength level of the in-band interference (Int@_Rcvr) must be below the receiver desensitization threshold (MAI_thres) in order not to cause collocated base station interference, Table 2 shows interference calculations on both WCDMA FDD and TDD systems at centre-to-centre frequency separations of 5 MHz, 10 MHz and 15 MHz. In all the cases the interference exceeds the defined threshold for Maximum Allowable Interference of -109 dBm. Both the systems arc subjected to an increase in noise floor.

TABLE 2

Calculated values **of** interference between **TDD** and **FDD** systems

Interfered system	C_Tx_	ACS of RX	ACLR of TX	ACIR	Int@_Rcvr	Threshold exceeded (-109dBm)
WCDMA TDD	43 dBm	46 @ 5 MHz	45 @ 5 MHz	42.46	–29.46 dBm	Yes
WCDMA TDD	43 dBm	58 @ 10 MHz	50 @ 10 MHz	49.36	–36.36 dBm	Yes
WCDMA TDD	43 dBm	66 @ 15 MHz	67 @ 15 MHz	63.46	–50.46 dBm	Yes
WCDMA FDD	40.2 dBm	46 @ 5 MHz	70 @ 5 MHz	45.98	–35.78 dBm	Yes
WCDMA FDD	40.2 dBm	58 @ 10 MHz	70 @ 10 MHz	57.73	-47.53 dBm	Yes
WCDMA FDD	40.2 dBm	66 @ 15 MHz	70 @ 15 MHz	54.34	–54.34 dBm	Yes

MAI_Over = 1 dB Compression Point – Safety Margin

A typical safety margin defined **by** operators is approximately 10 dB

3GPP specifications currently do not call out values for 1 dB compression points for the base station receiver, so this paper will calculate the appropriate values. Based on **3GPP** specifications, the Input Third Order Intercept Point of –22.8 dBm can be derived, and 1 dB compression point of –32.8 dBm is calculated as shown in the Table 3. This calculated 1 dB compression point, with the inclusion of a 10 dB safety margin, compares well with the blocking specification of –40 dBm given in 3GPP. Consequently, in this analysis, receiver overdrive is defined as occurring when the input receiver signal strength exceeds the 3GPP receiver blocking specification of –40 dBm. Additionally. expectations are that both the TDD and FDD systems would have similar RX characteristics in regards *to* receiver preamplifiers.

TABLE 3

Threshold for maximum allowable input signal strength for receiver overdrive

Category	Value
Input Third Order Intercept Point (IIP3)	–22.8dBm
1 dB compression point (IIP3 – 10 dB)	–32.8 dBm
MAI_Over (Calculated)	–42 dBm
Blocking specifications From 3GPP	–40 dBm

Interference at the receiver is dependant on the transmit power of the interfering station, transmit and receive filter characteristics, and the separation between the two base stations. The total carrier power received at the input of the interfered station can be calculated as:

$$\boxed{C\_RX\_ = C\_TX\_ - ACIR - MCL}$$

where:

C–RX– = Total carrier power received at input port of the interfered station (dBm)

MCL = Minimum Coupling Loss (dBm) = 30 dB

C_Tx_ = Total carrier power transmitted at the output port of the interfering station (dBm)

ACIR = 1/(1/ACS+1/ACLR).

Table 4 compares the interference signal at the WCDMA TDD and WCDMA FDD receivers (at various centre-to-centre frequency separations) to the blocking threshold as defined in 3GPP. At 5 MHz and 10 MHz channel separation, the WCDMA TDD system is driven into receiver overload conditions. The same conditions are also true for the WCDMA FDD system at 5 MHz channel separation

TABLE 4

Computed values showing interference at the RX of the interfered system

Interfered system	C_Tx	ACS of RX	ACLR of TX	ACIR	C_RX	MAI_Over threshold exceeded? (–40 dBm)
WC[redacted]TDD	43 dBm	46 @ 5 MHz	45 @ 5 MHz	42.46	–29.46 dBm	Yes
WC[redacted]	[redacted]	58[redacted]@ 10 MHz	50 @ 10 MHz	49.36	–36.36 dBm	Yes
WC[redacted]	[redacted]	[redacted]@ 15 MHz	67 @ 15 MHz	63.46	–50.46 dBm	No
WCDMA FDD	40.2 dBm	46 @ 5 MHz	70 @ 5 MHz	45.98	–35.78 dBm	Yes
WCDMA FDD	40.2 dBm	58 @ 10 MHz	70 @ 10 MHz	57.73	–47.53 dBm	No
	40 2 dBm	66 @ 15 MHz	70 @ 15 MHz	54 34	–54.34 dBm	No

4 Conclusion

The interference analysis presented in this paper shows that significant interference exists when TDD and FDD systems are collocated. The noise floor of both systems is impacted considerably, thereby decreasing cell coverage and capacity. Even a guardband of 5 MHz and 10 MHz will ***not*** eliminate the problem, as shown in the analysis. Without sufficient guardbands, interference conditions will also cause receiver overdrive of both systems. Sufficient guardbands must therefore be provided between TDD and FDD allocations. Continued investigation is required to define an appropriate guardband size considering real world operation issues such as base station collocation.

Assumptions (values taken from Document 8F/375, Attachment *8.6)*

System	RX noise floor	No. of carriers	BS TX Pwr	ACLR @ 5 MHz	ACLR @ 10 MHz	ACLR @ 15 MHz	ACS @ 5 MHz	ACS @ 10 MHz	ACS @ 15 MHz
WCDMA TDD	−108 dBm	1	43 dBm	70 dB	70 dB	70 dB	46 dB	58 dB	66 dB
WCDMA FDD	−108 dBm	1	43 dBm	45 dB	50 dB	67 dB	46 dB	58 dB	66 dB

ATTACHMENT C

DOCUMENT 8/67-E

INTERNATIONAL TELECOMMUNICATION UNION

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Working Party 8F

DRAFT NEW REPORT ITU-R M.[IMT.COEXT]

Coexistence between IMT-2000 TDD and FDD radio interface technologies within the frequency range 2 500-2 690 MHz operating in adjacent bands and in the same geographical area

(Question ITU-R 22918)

1 Introduction

1.1 Introduction and outline

In this document the coexistence between IMT-2000 TDD and FDD radio interfaces are investigated. Specifically, the interference properties between CDMA DS (WCDMA or UTRA FDD) and CDMA TC (UTRA TDD) with its two modes high chip rate (HCR, **3.84** Mchip/s) TDD and low chip rate (LCR, 1.28 Mchipis) TDD are studied for **a** large number of scenarios.

The main part of the document describes base station to base station (BS-BS) interference for both proximity and co-location scenarios. Also mobile station to base station (MS-BS), base station to mobile station (BS-MS) and mobile station to mobile station (MS-MS) scenarios are studied for proximity scenarios.

In § 2.4-2.5, the transmitter and receiver characteristics are described. In § 2.8 the relation between the **external** interference level, and coverage and capacity is discussed. In § 3.2 the methodology of the deterministic BS-BS and MS-MS scenarios is described. The Monte Carlo methods are described in § 3.3. The results are presented in **$ 4** and conclusions are made in § **5.**

An overview of the results can be obtained by reading §§ 1, 2.1-2.3, and **5**,

1.2 Scope

For the purposes of the analysis in this report it has been assumed that TDD and FDD systems at 2.5 GHz will have similar characteristics to those of WCDMA and HCR/LCR TDD as given in Recommendation ITU-R **M.**1457.

1.3 Summary

This report provides an analysis and present results of the consequences of adjacent channel interference on FDD and TDD compatibility for a number of scenarios. This study is based on deterministic calculations for BS-BS scenarios leading to required separation distance and/or isolation requirements or supported cell range. The interference from mobile stations into mobile stations and base stations is analysed both with deterministic and statistical calculations leading to capacity loss and/or probability of interference.

The feasibility of certain scenarios is subject to a trade–off between technical, regulatory and economical factors, In the document, different points of view have been reflected on factors such as propagation conditions, user density and placement, which correspond to different trade–off choices. The above views by no means exclude other points of views. The conclusions below reflect only the studies made in this document.

It is recognised that any potential improvement brought about by mitigation techniques such as site engineering, adaptive antenna, etc, is not covered in this report and should be the subject of further study.

Main results

BS-BS interference: General observations

- Several scenarios and parameter settings examined are associated with severe interference problems.
- The separation distances have been calculated over an interval of tolerated external interference where the smaller value for separation distance implies high levels of planned tolerated external interference which in turn implies smaller coverage and/or capacity and higher transmit powers for the MS in the victim system.
- There is no fundamental difference in magnitude of interference when considering FDD downlink (DL) to TDD uplink (UL) interference or when considering TDD DL to FDD UL for any of the examined scenarios.
- Thus, the potential problems come from the basic fact that DL transmitters are geographically and spectrally close to sensitive UL receivers, regardless of the duplex method involved.
- Minimum requirements available in 3GPP specifications on transmitter and receiver characteristics are assumed to the maximum extent possible. It could be noted that practical equipment may be better than required in the specifications.
- For several scenarios large values of separation distances or additional isolation are needed to obtain low interference conditions. Some scenarios have low separation distances and do not require additional isolation.
- In some deployment scenarios separation distances or filtering requirements can be traded off against coverage and higher MS transmit powers in the victim system.
- There are a number of basic actions that can be taken alone or in combination in order to combat the BS-BS interference problems. **All** actions are associated with some kind of cost or other difficulties that must be taken into account as well, as there is always a trade-off to consider.

BS-BS interference in proximity: **WCDMA/3.84 Mchip/s TDD**

The required separation distances are in a range from I m to 15 km depending upon the cell types involved and carrier separation used. They are the lowest forpico-to-pico scenarios and the highest for macro-to-macro scenarios.

BS-BS interference in proximity: **WCDMA/1.28 Mchip/s TDD**

Based on assumptions for reference separation distances, only the macro-to-macro scenario requires significant additional isolation. For other scenarios, the basic isolation is sufficient.

BS-BS co-location: **WCDMA/3.84 Mchip/s**

- Co-location of base stations will be prevalent in future systems
- When WCDMA and 3.84 Mchip/s macro base stations are co-located the noise floor of both systems are impacted considerably when considering a 30 dB coupling loss
- Coverage and capacity will be severely affected, if appropriate isolation is not provided between the base stations.
- Based on the existing specifications and minimum coupling loss (MCL) assumptions, even a guard band of **5** MHz and 10 MHz will not remove the problem.

- Continued studies must define needed system specifications and guard bands, as appropriate, considering base station co-location, taking into consideration the fact that some degree of isolation may be achieved in practical systems.

MS-BS, BS-MS interference

- For the studied Manhattan scenarios with uniformly distributed outdoor-only users, Monte Carlo simulations suggest that MS-BS, BS-MS interference will have a small or negligible impact on the capacity when averaged over the system.

MS-MS interference

- The Monte Carlo simulations suggest that MS-MS interference will have a small or negligible impact **on** the capacity when averaged over the system and using uniform user densities (see § 4.2.2.3).
- Deterministic MS-MS calculations suggest that one mobile might create severe interference to another geographically and spectrally close mobile (see § 4.2.3).
- Studies are therefore needed where non-uniform user densities are considered, which are more realistic in real systems in hot spot areas. (see § 4.2.3)
- The outage cannot be reduced much even at the cost of **BS** density or capacity decrease. Instead, the requirements should be set on the service level.

2 Assumptions

2.1 Radio interface technologies considered

In this paper the IMT-2000 technologies considered are the FDD based IMT-2000 CDMA direct spread (also known as WCDMA) radio specification and the TDD based IMT-2000 CDMA TC with its two modes HCR TDD (3.84 Mchipis) and LCR TDD (also known as TD-SCDMA, 1 28 Mchip/s)

They are for simplicity referred to as FDD and TDD, respectively, in the appropriate sequence.

2.2 Interference scenarios

This paper considers the following basic scenarios.

- Interference to FDD BS caused by TDD BS (Deterministic calculations)
- Interference to TDD BS caused by FDD BS (Deterministic calculations)
- Interference to FDD BS caused by TDD user equipment (UE) (Monte Carlo simulations)
- Interference to TDD BS caused by FDD UE (Monte Carlo simulations)
- Interference to FDD UE caused by TDD UE (Monte Carlo simulations)
- Interference to TDD UE caused by FDD UE (Monte Carlo simulations)
- Interference to FDD UE caused by TDD BS (Monte Carlo simulations)
- Interference to TDD UE caused by FDD BS (Monte Carlo simulations)
- Interference to FDD UE caused by TDD UE (Deterministic calculations)
- Interference to TDD UE caused by FDD UE (Deterministic calculations)

The methodology used in the calculations and simulations is described in § 3

2.3 Involved cell layers

All scenarios should be considered, i.e. macro, micro and pico. However, not all *combinations* of PDD and TDD cell layers have been investigated since some are considered less likely,

Frequency allocation

The study focuses on coexistence in the IMT-2000 band between 2 **500** and 2 **690** MHz. **A** principle allocation according to Figure 1 is assumed. This study focuses on interference between TDD and FDD UL as well as TDD and FDD DL. Interference between FDD **UL** and FDD DL is not considered (because of the frequency separation). No particular assumptions on the **sizes of** the bands have been made since the focus is on the ***border*** effects between FDD UL and TDD, and TDD and FDD DL, respectively.

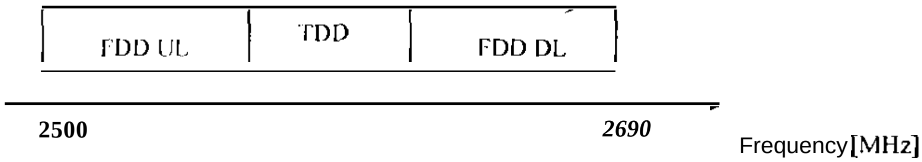

FIGURE 1

Assumed frequency allocation

It is assumed in the calculations that the TDD and FDD bands are separated with a certain amount of bandwidth (possibly of zero width). The carrier separation is defined as the spectral distance between the centre frequencies of the respective bands, including possible guardbands.

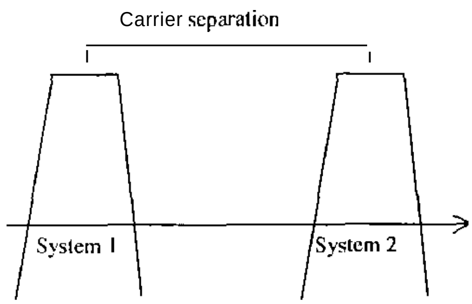

FIGURE 2

Carrier separation

The carrier separation thus consists of half the bandwidth of system 1 **plus** half the bandwidth of system 2 *plus* possibly extra guardband. For WCDMA/3.84 Mchip/s TDD the carrier separation is a minimum 2.5 + 2.5 = **5** MHz and for WCDMA/TDSCDMA it is minimum 2.5 + 0.8 = **3.3** MHz.

With **5** MHz extra guardband the carrier separation thus becomes **10** or 8.3 MHz, respectively.

Deployment scenarios and base station position

In this study, different types of base stations (for both FDD and TDD deployment) are considered (macro, micro and pico). **A** *macro* base station is assumed to be located above rooftop and to be deployed in areas with both high and low user densities. The main objective of the macro base stations is to achieve coverage over a relatively large area.

A *micro* base station is assumed to be located outside below rooftop and are deployed in areas with high user densities. The micro base stations are mainly used to enhance the capacity in areas with high user densities.

The *pico* base station is located indoors and used for indoor coverage only. Typical deployment scenarios are in an office building. The pico base station could in principle be located at any floor within a building. However, it is here assumed that the height of **the** pico base station is approximately the same as the height of a micro base station.

The assumed heights of the different base stations are summarized in Table 1. Furthermore, the average building height is assumed to be **24** m and thus, the macro base stations are positioned **6** m above the average rooftop.

TABLE I

Assumed heights of the macro, the micro and the pico base station (both FDD and TDD)

Base station type	Height m
Macro	30
Micro	6
Pico	6

2.4 Transmitter characteristics

The transmitter characteristic includes output power restrictions and transmitter antenna gain.

2.4.1 Output power and antenna gain

The **BS** maximum output power and antenna gain for FDD and TDD base stations are found in Table **2.**

TABLE **2**

Maximum output power and Tx antenna gain for the macro, micro and pico base stations (FDD and TDD)

BS type	**Maximum output power dBm**	**Antenna gain (tx) dBi**
FDD macro	43	15
FDD micro	30	6
FDD pico	**24**	**0**
macro		
3.84 Mchipis TDD micro	**30**	**6**
3.84 Mchipis TDD pico	**24**	**0**
TD-SCDMA	**34***	**15**
TD-SCDMA micro	21*	*6*
TD-SCDMA pico	**12***	**3***

TABLE **3**

Maximum output power and Tx antenna gain for FDD and TDD MSs

MS type	**Maximum output power dBm**	**Antenna gain (tx) dBi**
FDD	21	0
TDD	21	0

2.4.2 Spectrum masks and ACLR values

The BS ACLR **values** in Table **4** are from (I) and (2) respectively. **For** the TDD BS, the ACLR requirement refers to the case of coexistence with other (TDD or FDD) systems.

The below values are valid for 3.84 Mchipis TDD. For 1.28 Mchip/s TDD, see § 2.6